IN THE CLAIMS

1. (Previously Presented) An integrated circuit package comprising:

an integrated circuit die having an active surface; and

a cooling fluid to directly contact and move laterally across the active surface.

2. (Original) The integrated circuit package of claim 1 further comprising:

an interposer coupled to the integrated circuit die.

3. (Original) The integrated circuit package of claim 2, wherein the interposer has a microchannel surface that allows the cooling fluid to flow between the interposer and the active surface of the integrated circuit die.

4. (Original) The integrated circuit package of claim 2 further comprising:

a package substrate, wherein a first side of the interposer is coupled to the package substrate via solder bumps, and a second side of the interposer is coupled to the integrated circuit die via solder bumps.

5. (Original) The integrated circuit package of claim 4 further comprising:

an underfill material disposed substantially between the interposer and the package substrate.

6. (Original) The integrated circuit package of claim 1, wherein the integrated circuit die has a microchannel surface.

7. (Original) The integrated circuit package of claim 1 further comprising:
a pump to circulate the cooling fluid.

8. (Previously Presented) A method of forming an integrated circuit package comprising:

attaching an interposer to a package substrate;

attaching an integrated circuit die to the interposer, wherein the integrated circuit die includes an active region;

covering the package substrate, the integrated circuit die, and the interposer with a heat spreader to form an internal chamber;

filling the internal chamber with a cooling fluid, wherein the cooling fluid contacts a region between the interposer and the integrated circuit die and wherein the cooling fluid is to directly contact and move laterally across the active region.

9. (Original) The method of claim 8, wherein the filling of the internal chamber is done by pumping cooling fluid through a via in the package substrate.

10. (Previously Presented) A method of forming an integrated circuit package comprising:

attaching an interposer to a package substrate;

attaching an integrated circuit die to the interposer;

covering the package substrate, the integrated circuit die, and the interposer with a heat spreader to form an internal chamber;

filling the internal chamber with a cooling fluid by pumping cooling fluid through a via in the package substrate and

sealing the via after the internal chamber is filled.

11. (Previously Presented) A method of forming an integrated circuit package comprising:

attaching an interposer to a package substrate;

attaching an integrated circuit die to the interposer;

covering the package substrate, the integrated circuit die, and the interposer with a heat spreader to form an internal chamber;

filling the internal chamber with a cooling fluid by pumping cooling fluid through an inlet and sealing closed the inlet when the filling is complete.

12. (Previously Presented) A method of cooling an integrated circuit die within an integrated circuit package comprising:

providing power to the integrated circuit die; and

moving a cooling fluid laterally across and in direct contact with an active surface of the integrated circuit die.

13. (Original) The method of claim 12, wherein the moving of the cooling fluid is performed by thermal convection.

14. (Original) The method of claim 12, wherein the moving of the cooling fluid is performed by a pump located inside of the integrated circuit package.

15. (Original) The method of claim 12, wherein the moving of the cooling fluid is performed by a pump located outside of the integrated circuit package.

16. (Original) The method of claim 12, wherein the cooling fluid changes phase by evaporating at a first location of the integrated circuit package and condensing at a second location of the integrated circuit package.

17. (Previously Presented) An integrated circuit package comprising:

a package substrate;

a first integrated circuit die having an active surface;

an interposer disposed between the package substrate and the first integrated circuit die, the interposer establishing electrical connectivity between the first integrated circuit die and the package substrate; and

a cooling fluid disposed between the first integrated circuit die and the interposer, wherein the cooling fluid is to directly contact and move laterally across the active surface.

18. (Original) The integrated circuit package of claim 17 further comprising:

a heat spreader covering the package substrate, the first integrated circuit die, the cooling fluid, and the interposer.

19. (Original) The integrated circuit package of claim 18 further comprising:

a heat sink coupled to the heat spreader.

20. (Original) The integrated circuit package of claim 18, wherein the first integrated circuit die has a microchannel surface in contact with the heat spreader, the microchannel surface allowing cooling fluid to flow across the microchannel surface.

21. (Cancelled)

22. (Original) The integrated circuit package of claim 17, wherein the interposer provides electrical functionality in addition to electrical connectivity.

23. (Original) The integrated circuit package of claim 22, wherein the interposer provides capacitance.

24. (Original) The integrated circuit package of claim 22, wherein the interposer comprises a second integrated circuit die.

25. (Original) The integrated circuit package of claim 24, wherein the second integrated circuit provides an optical to electrical interface for the first integrated circuit die.

26. (Original) The integrated circuit package of claim 17, wherein the interposer has a microchannel surface in contact with the active surface of the first integrated circuit die.

27. (Previously Presented) An integrated circuit package comprising:

a integrated circuit die housed within a chamber, wherein the integrated circuit die includes an active region; and

a cooling fluid filling the chamber and to directly contact and move laterally across the active region of the integrated circuit die.

28. (Original) The integrated circuit package of claim 27 further comprising:

a plurality of microchannels in a surface of the integrated circuit die.

29. (Original) The integrated circuit package of claim 28 further comprising:

a pump located within the integrated circuit package to pump the cooling fluid through at least a portion of the plurality of microchannels.

Objections to Drawings

The Examiner objected to the drawings under 37 CFR 1.83(a) for failing to show every feature of the invention specified in the claims. The Examiner objected to the drawings for not depicting "pump located inside of the integrated circuit" in Claim 14. Claim 14 recites in part "pump located inside of the integrated circuit package" (emphasis added). The specification recites:

> Figure 2 is a schematic diagram that shows one embodiment of an integrated circuit package 105 having a cooling fluid 108. An integrated circuit die 110 is coupled to an interposer 114 that provides electrical connectivity between the integrated circuit die 110 and the package substrate 120. In one embodiment, the integrated circuit die 110 is coupled to the interposer 114 via solder bumps 130, and the interposer 114 is also coupled to the package substrate 120 via solder bumps 132. An underfill material 140 fills the space between the interposer 114 and the package substrate 120. In one embodiment, both the integrated circuit die 110 and the interposer 114 comprise the same material. (Page 4, lines 13-21) (emphasis added).

The specification further recites:

> In one embodiment, the microchannels 170 are formed via any of various micromachining techniques such as etching or using a focused ion beam. However, the microchannels 170 may alternatively be formed via other techniques such as, but not limited to, milling. In one embodiment, the microchannels 170 may have a depth of approximately half the depth of the integrated circuit die 110 and/or interposer 114. (Page 7, lines 3-8).

The specification further recites:

> Figure 3 is a schematic diagram that shows one embodiment of a top view of a microchannel surface such as that of the integrated circuit die 110 or the interpose 114. In one embodiment, electrical connection to the microchannel surface may be achieved through solder bumps 130, such as those between the integrated circuit die 110 and the interpose 114. The solder bumps 130 may help form channels that funnel the cooling fluid substantially along the same path as the microchannels 170. (Page 7, lines 18-23) (emphasis added).

Clearly Figures 2 and 3 support the cited language of Claim 14.

Examiner objected to the drawings for failing to depict "optical to electrical interface for the first integrated circuit die" of Claim 25. The specification recites:

> In one embodiment, the interposer 114 may comprise a second integrated circuit die that provides additional functionality. For example, the interposer 114 may serve as an optical to electrical interface for the first integrated circuit die 110. Thus, an optical signal may be input to the interposer 114, which provides a corresponding electrical signal to the first integrated circuit die 110. (Page 5, lines 1-8) (emphasis added).

Clearly Figures 2 and 3 support the cited language of Claim 25. The Applicants respectfully request that the Examiner withdraw the objection to the drawings.

Allowed Claims

Claims 10 and 11 stand allowed.

Claim Rejections under 35 U.S.C. §102(b)

In the office action dated January 29, 2004, the Examiner rejected claims 1-3, 6-9, 12-20, 22-24, and 26-29 under 35 U.S.C. §102(b) as being unpatentable over Fujisaki et al. (U.S. patent 5,763,950) ("Fujisaki"). The Examiner stated "Fujisaki et al. disclose a integrated circuit chips/package comprising an integrated circuit die having an active surface 11, and a cooling fluid/ coolant 235 directly contact and move across the active surface" (page 2 of office action dated January 29, 2004).

Fujisaki discloses "semiconductor element 11" having "top surface 11a" mounted to a "circuit substrate 12 via a plurality of connecting members 13 such as solder" (col. 1, lines 33-36). Fujisaki discloses "semiconductor element 11 is cooled when a coolant (cooling medium) 15 flows parallel to the circuit substrate 12 and passes the periphery of the semiconductor element 11. In other words, the cooling takes place due to heat exchange between the coolant 15 and the pin-shaped fins 14 and the top surface 11a of the semiconductor element 11" (col. 1, lines 39-44) (emphasis added).

Fujisaki does not teach "cooling fluid to directly contact and move laterally across the active surface" of Claim 1 or "cooling fluid is to directly contact and move laterally across the active region" of Claim 8 or "moving a cooling fluid laterally across and in direct contact with an active surface of the integrated circuit die" of Claim 12 or "cooling fluid is to directly contact and move laterally across the active surface" of Claim 17 or "a cooling fluid ... directly contact and move laterally across the active region of the

integrated circuit die" of Claim 27. Accordingly independent claims 1, 8, 12, 17 and 27 are allowable over the teachings of Fujisaki. Claims 2-3, 6, 7, 9, 13-16, 18-20, 22-24, 26, 28, and 29 depend from independent claims 1, 8, 12, 17 and 27 and thus are allowable for at least the same reasons as pertain to claims 1, 8, 12, 17 and 27.

Claim Rejections under 35 U.S.C. §103(a)

The Examiner rejected Claims 4, 22, 23, and 25 under 35 U.S.C. 103(a) as being unpatentable over Fujisaki in view of Patel (U.S. patent no. 5,396,403) (hereafter "Patel"). Patel fails to cure the stated deficiency of Fujisaki with respect to claims 1 and 17. For at least that reason, Claims 4, 22, 23, and 25 are allowable over the teachings and suggestions of Fujisaki in view of Patel.

The Examiner rejected Claim 5 under 35 U.S.C. 103(a) as being unpatentable over Fujisaki in view of Patel and further in view of Lin et al. (U.S. patent no. 6,188,578) (hereafter Lin). Lin fails to cure the stated deficiency of Fujisaki in view of Patel as described with respect to Claim 1. For at least that reason, Claim 5 is allowable over the teachings and suggestions of Fujisaki in view of Patel and further in view of Lin.

Accordingly, Applicants request allowance of Claims 1-20 and 22-29. If the Examiner has any questions concerning this application, please call the applicants' attorney at (212) 661-5488.

If there are any additional charges, please charge Deposit Account No. 02-2666.

Respectfully submitted,

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